SUGGESTIONS AS TO LINES
FOR FUTURE RESEARCH

BY

A. H. SMEE. M.R.C.S. F.C.S. F.S.S.


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SUGGESTIONS AS TO LINES FOR FUTURE RESEARCH,

BEING THE SUBSTANCE OF

THE ORATION

DELIVERED AT

THE HUNTERIAN SOCIETY OF LONDON,

FEBRUARY 9TH, 1881.

BY

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TO THE MEMBERS

OF THE

HUNTERIAN SOCIETY OF LONDON

THIS BOOK,

BEING THE SUBSTANCE OF THE ORATION

DELIVERED BEFORE THE SOCIETY, FEBRUARY 9TH, 1881,

IS RESPECTFULLY DEDICATED

BY

THE AUTHOR.

The Grange,

Hackbridge.

A

MR. PRESIDENT AND GENTLEMEN—

We are here this day to celebrate the Sixty-second Anniversary of this Society, and to do honour to the memory of JOHN HUNTER, after whom our Society has been named.

At the request of the Council, last year, I was asked to give the oration to-night. I have therefore thought it right, not only to study the life and character of Hunter himself, but I have also endeavoured to consider in what manner his mind might have been influenced in his researches had he possessed our present knowledge.

After reading many of the able discourses which have been given by such orators as Paget and others, setting forth the character and achievements of John Hunter, it would be impossible for me to bring under your notice any new fact connected with his life which has not been previously made known It has, therefore, occurred to me that it might be advantageous to attempt to follow out the spirit which guided Hunter in his work.

I shall endeavour, very imperfectly however, to bring under the notice of the Members of this Society the bearing of some researches on the chemistry of

animal life, and to point out some fresh lines which may yield good fruit by fuller investigation.

I cannot help considering it unfortunate that the advance made in physiological chemistry during the last few years has been comparatively small compared with the great stride which has been made in microscopic anatomy and our knowledge of human and animal pathology.

I believe that if medical students had a more thorough knowledge of inorganic and animal chemistry, and were better acquainted with the researches of Chemical Physics, many phenomena and changes which take place in disease would be better understood, and the causes would with far greater probability be discovered.

Whether the study of this branch of the physical sciences is neglected by our students through apathy or from a belief that the chemistry of the laboratory differs from the chemistry of animal life, in that the latter is influenced by a vital force; it is unquestionable that the medical profession, as a body, have a very imperfect knowledge of physical and physiological chemistry.

I cannot help thinking that the want of interest in chemistry is aggravated by "cram," that "curse" to real knowledge, a monster which has arisen and thrives on the examination system now in vogue; a system which causes the student to seek to learn, and the teacher to attempt to teach, only those sub-

jects which pay at the examination. The student is carefully taught by the tutor not to seek or attempt to trace the hidden and unknown springs, but only to follow those broad rivers which flow through the pages of the latest text-book. In fact the higher the standard fixed by the examiners, the more thoroughly must the student drive from his mind any individuality of thought, and, to be successful, must be most careful to train his mind to eliminate all views which are speculative, or in the least doubtful, or have not yet received the official stamp of accuracy by admission to the text-books; then, graduating with honours, he has succeeded in diminishing his power for observation, diminished his power for generalization, and produced that highly valuable commodity, a walking encyclopædia of printed matter for the time being, the very antithesis of the life and character of him whose memory we are here to-night to celebrate. It must be understood that I am not an advocate for the total abolition of an entrance examination to our profession. But for the higher positions of Fellowships or M.D. degrees, I think some evidence of original research should be demanded from the candidate. The present system, I do not hesitate to state, is gradually levelling down the higher grades of the profession, and assimilating them more and more to those of mere membership or Licentiate of the Society of Apothecaries qualification.

Let me digress a little further to illustrate the educational defects of which I speak. Holding the official position of medical adviser to an assurance company, over 1,000 certificates come before me yearly from every class of medical practitioners. I have noticed that, year by year, for the last fifteen years, the number of cases increase in which, if the diagnosis of the medical attendant was right, his prognosis was manifestly wrong, or *vice versâ*. The certificates from the younger members of the profession give evidence that their knowledge was more and more acquired in the class-room and through text-books, and show that less and less time has been given by them to the practical work of the surgery and out-patient room.

The following certificates have come under my notice during the last few weeks, and may be taken as types to illustrate my statement:—

For a fractured radius, a Fellow of the College certified that his patient would be disabled nineteen days, and this, too, for a man whose occupation necessitated the constant use of the arm.

A surgeon certified to a fractured leg; the patient was not, and had not been confined to the house, bed, or bedroom.

A medical practitioner, only this week, with M.D. amongst his qualifications, gave a certificate, with the following as a foot-note, for a man who had fractured his toes, "These injuries are generally treated in our district by the bone-setter."

I should weary the Society by relating the number of certificates in which simple cut heads are returned for fractured skulls.

Of course it would be easy to point out many brilliant members of our profession who have passed through this mill without any injury to their powers of observation, etc.; but many, having passed their examination with distinction (this being the height of their ambition), have led themselves into the belief that they have attained the highest and final pinnacle of knowledge.

To return from my digression: I should like to see the lecturers on chemistry at our medical schools devote more time to the illustration of the use and properties of those alkalies, metals, and alkaloids which enter into the composition of the animal economy; to make the student acquainted with the chemical phenomena of physiological chemistry; to teach him to have a practical knowledge of the laws of osmosis, transfusion, the transpiration of gases through colloid septa; above all, the analogy of inorganic to organic colloids, the method of testing and examining the constituents of the secretions and excretions; that he should be able to detect the presence of organic impurities in water; that he should clearly comprehend the merits and disadvantages of the results which are obtained by the employment of the combustion method of Frankland for water analysis, the ammonia

determination of Wanklyn, and the oxidation method of Tidy. He should be taught to form his own judgment upon the value which each of these chemists attach to the presence of the various forms of organic carbon and nitrogen contained in potable waters. It would be well not to weary the student with the consideration of those branches, and the theories of organic chemistry, which are only suited to one who purposes making chemistry his profession.

Professor Thomas Graham has shown that gases pass through colloid septa of indiarubber in inverse ratio of the square root of their densities. Thus oxygen passed through at a greater rate than nitrogen, and carbonic acid far more rapidly than oxygen. He has also shown that both temperature and pressure within certain limits favoured the dialytic separation of the gases. The method he adopted was, to attach to the pneumatic instrument of Dr. Sprengel, small balloons or cells of indiarubber, whose action may be compared to capillary circulation of the air-cells of the lungs, and then examine the air that passed through the Indiarubber cell.

It is remarkable that gutta percha, which has the same chemical formula as Indiarubber, and has been regarded by many chemists as an isomeric body, will not separate the gases. The proportion of oxygen in air dialysed by rubber appears to be 41·5 per cent., that is, the atmospheric air is deprived of one-half

the usual proportion of nitrogen, but the air seems to simply percolate through gutta percha.

Now would it not be worth the attention of pathologists to investigate whether lung tissue may not alter its power of dialytic action in disease. It may be that the dyspnœa of bronchitis is produced by the inability of oxygen to pass through the lung cells, which, in the early stages of phthisis, might be found to pass through in excess. I believe by a careful examination of the physical properties of diseased lung, many new and valuable facts would be discovered which would be of use to the physician.

Again, the analogy between organic colloids and fluid silicic acid, which is prepared by the adding hydrochloric acid to silicate of soda, and then dialysing out the salt to organic colloids is so curiously suggestive that I may quote Graham's words on liquid diffusion and the properties of fluid silicic acid. He says:—

"The comparative fixity of that liquid with the glycerine compounds indicate the possession of a wider range of affinity by a colloid than could well have been anticipated. The organic colloids are no doubt invested with similar wide powers of combination, which may become of interest to the physiologist. The capacity of a mass of gelatinous silicic acid to assimilate alcohol or even olein in the place of water of combination without disintegration or alleviation of form may perhaps afford a clue to the penetration

of albuminous matter of membrane by fatty and other insoluble bodies which seem to occur in the digestion of food. Still more remarkable and suggestive are the fluid compounds of silicic acid. The fluid alcohol compounds favours the possibility of the existence of a compound of the colloid albumen with olein, soluble also, and capable of circulating with the blood."

The feebleness of force which holds together two substances belonging to different physical classes, one being a colloid, and the other a crystalloid, deserves notice. Thus in hydrated silicic acid, the combined water (crystalloid) leaves the acid (colloid) to diffuse into alcohol, and if the alcohol be repeatedly changed, the entire water is thus removed; alcohol (another crystalloid) at the same time taking the place of water in combination with silicic-acid forming alcosel. But with alcogel, the solid combination of alcohol with silicic acid, the process is reversed, alcohol dialysing out, and water entering into combination.

A tendency to spontaneous change, which is observed occasionally in crystalloids, appears to be a constant property with colloids. The fluid colloid become pectous and insoluble, *i.e.*, coagulated by contact with certain substances such as graphite, without combining with these substances, and the change of condition often takes place, Graham states, apparently by time alone.

The chemical equivalent of a colloid appears to

be always high, although the ratio between the elements may be simple. Gummic acid, for instance, may be represented by the formula $C_{12}H_{11}O_{11}$, but judging from the small proportions of lime and potash which suffice to neutralise the acid, the true number of its formula must be several times higher. It is difficult to avoid associating the inertness of colloids with their high equivalents, especially where the high number appears to be attained by the repetition of a smaller number. Thus with silicic acid, which exists in combination as a crystalloid and colloid, we have two series of compounds, silicate and co-silicate, the latter appearing to have an equivalent much greater than the acid of the former. Ice itself is in a colloid state when it is at or near its melting point; but the flakes of snow, whether produced by hoar frost or by Faraday's experiment of water frozen by dilute sulphuric acid, is in a crystalloid condition.

A similar condition takes place in a colloid holding a high place in the albuminoid series, in the so-called blood crystals of Funke, a soft and gelatinous albuminoid body which assumes a crystalloid form.

Liquid silicic acid becomes pectous by the addition of graphite; it also becomes pectous by time alone: this change is permanent, and loses its miscibility with water. A dilute solution remains fluid for a considerable time, but by a concentration of the solution or an elevation of temperature, spontaneous pectization, takes place; thus 10 per cent. solution becomes

pectous in a few hours ; 5 per cent. solution becomes pectous in five or six days ; 2 per cent. solution becomes pectous in two or three months : and 1 per cent. remains fluid after two years. Liquid silicic acid kept in closed tubes is in a favourable condition for keeping fluid.

From a consideration of the above facts it appears to me probable that the coagulation of the fibrine in blood is merely a physical act, and not the last vital act of the blood, nor yet is it a chemical change as usually understood.

The following experiments which I have made upon fresh-drawn blood illustrate the manner in which fibrine pectizes in animal fluids.

On the addition of an equal quantity of a solution of sulphate of soda to fresh-drawn blood coagulation will not take place, and the blood will remain fluid an indefinite time. The blood-cells however will gradually subside, leaving the liquor sanguinis containing the uncoagulated fibrine bright and clear. If some of this liquor sanguinis is placed in a dialyser, and then the dialyser placed in distilled water, in the course of a few hours the sulphate of soda will dialyse cut of the liquor sanguinis, and a thin gelatinous film of fibrine will be formed at first, in direct contact with the parchment paper of the dialyser. This film of fibrine will gradually extend, and become thicker as the sulphate of soda slowly dialyses out of the solution ; and after the lapse of 10 or 12 hours the

whole will have become one uniform structureless clot. This clot will, after some days, contract, squeeze out the liquor sanguinis, lose its structureless appearance, and split up into fibres.

If a second quantity of the mixed liquor sanguinis is placed on the dialyser which has been previously coated with fibrine jelly, the second quantity will require a greater length of time for coagulation to begin. This is especially the case if a cup-shaped depression has been made in the fibrine jelly for the second quantity of the liquor sanguinis. When the solution of sulphate of soda is added to the liquor sanguinis in excess, the time of coagulation is delayed in direct ratio to the quantity of the sulphate of soda added to fresh-drawn blood.

If the fluid which is placed upon the dialyser contains not more than one part of the liquor sanguinis to 30 parts of the sulphate solution no pectization will take place, even after the sulphate has been removed by long-continued dialysing; and probably the fibrine remains fluid upon the dialyser sufficiently long to get oxydized, and converted into some other substance. The fibrine jelly formed by dialysing is dissolved slowly in caustic potash, leaving behind a small quantity of hexagonal crystals which are soluble in acetic acid. I have placed fibrine jelly which has been redissolved in potash upon a dialyser to remove the alkaline salt, but I have failed in every instance to get the film a second time to pectize.

I have observed a very curious property in fibrine jelly (which has been made from a dilute solution) of breaking up and becoming again fluid, and passing through the blotting paper filter used to separate the liquor sanguinis from the fibrine jelly. I can find no satisfactory explanation of this remarkable change, but it would seem to show that very minute causes are sufficient to determine the physical condition of colloid substances.

The analogy between fibrine and silica in their physical behaviour will be best observed by comparing their properties together. 1st. Fibrine and silica colloidal substances are known to exist in the fluid as well as the coagulated condition. 2nd. When either fibrine or silicic acid assumes the pectous state it is incapable of being *per se* redissolved, so as again to be able to spontaneously pectize. The existence of both these substances is a continual metastasis: fibrine is a typical instance of this metastasis. 3rd. All colloids in the fluid condition, whether of organic or inorganic origin, after an interval of time, longer or shorter according to their specific characters, spontaneously coagulate. 4th. This coagulation takes place without the intervention of any chemical agent which is capable of producing a change in that colloid. 5th. The addition of neutral salts to inorganic colloids in a fluid state (just as the falling of a speck of dust into the supersaturated solution of sulphate of soda favours crystallization) favours the

coagulation of those colloids. The neutral salts in these cases must be regarded as foreign bodies. Possibly the white blood-cells, altered in their physical condition by exposure to air, become as foreign bodies to the blood, and have a similar influence to that of the twigs and rods used ordinarily to defibrinate blood.

Lastly, the capacity of all colloids to remain in the fluid condition is greatly promoted. 1st. By the weakness of the solution (less than 10 per cent.); 2nd. By being contained in sealed vessels.

The time required by a fluid colloid to pectize apparently depends upon its molecular equivalent.

The fluid condition appears to be less stable in colloids with high molecular equivalents, in direct ratio to the molecular equivalent of the colloid; the act of pectizing takes place more rapidly and with less apparent cause. Consequently, soluble peroxide of iron pectizes sooner than alumina, and alumina more rapidly than silica. Therefore, when we come to fibrine, a molecular equivalent vastly higher than either of these colloids, we see reason for expecting that it would coagulate almost immediately.

Occasionally masses ot natural silica containing fluid are found in nature, of which I myself possess a remarkably fine specimen. These appear to me to have a great resemblance in the manner of their formation to that of the blood-tumours described

by Morrant Baker. The enclosed fluid may be analogous to that in Lester's experiment, where fibrine ceased to coagulate or separate when passed through a tube which had been previously coated with blood-fibrine.

In the case of the natural stone what has taken place? 1st. Silica has been deposited. 2nd. Coagulation has taken place; and the coagulum has contracted and formed a cavity in its inner surface. 3rd. The addition of more (fluid) silica has taken place; and the external coagulum has been transformed, passing, after the lapse of time, from the vitreous to the crystallized state.

The second quantity of the fluid silica has coagulated; but it has coagulated in the gelatinous form, squeezing out the remaining water.

Compare what has taken place in the formation of blood-tumours. 1st. Blood is effused; 2nd. The fibrine is coagulated; 3rd. The coagulum contracts and becomes organized into the dense hard fibrous margin. If a second effusion of blood now takes place the blood will remain fluid, and will remain so for a considerable length of time; but at last the fibrine will coagulate, squeezing out physically the liquor sanguinis.

To my mind the analogy between the formation of the fibrine in a blood-tumour and the deposition of silicic acid in certain natural stones is complete.

I have noticed that silicic acid has the property

of replacing some organic substances. Thus, the leaf of a plant, muscular fibre, ring of the trachea of a fly, and even a blood-corpuscle, may be replaced molecule by molecule by silicic acid, and after carefully drying may be exposed for many hours to a white heat and still retain the microscopic structure of the leaf or fibre. The method I have adopted for these experiments was very simple: it was to place the muscular fibre and other substances to be silicified in a solution of silicate of soda (sp. g., 1010-1015), to which a few drops of peroxide of hydrogen had been added. By this means silicate of soda dialyses into the tissues, the tissues are gradually destroyed by oxidation, the soda dialysing out in combination with the products of animal matter, and silicic acid in a pectous state is deposited in the structure of the fibre. We may speak of the process as an artificial and inorganic nutrition that has been established, the peroxide representing oxygen carried by the arterial blood cells; and silicate of soda representing the soluble albuminous matter in the blood being carried to the muscle, which normally would by use be replenished by fresh and unstable albumen. Artificially, the muscular waste has been replenished by silicic acid, a stable and pectous substance capable of no further change. The products of the oxydation of the muscular tissue are found in the fluid, which must be replenished from time to time.

Thus the analogy of the changes which take place in animal economy to that of the laboratory experiment would seem to be complete.

Graham states that the intervention of a colloid septum, formed by a layer of animal mucus (as from the stomach) placed between two layers of calico, cannot be said to impede the diffusion of crystalloids, but appears to retard the diffusion of colloids, such as gum. He has also shown that osmosis is considerable through membrane, and other hydrated septa with the solution of any colloid contained in the osmometer, yet the diffusion from the colloid is always minute, whilst the entrance of water towards the colloids was very rapid.

From these facts I was induced to make a series of observations on the properties of various forms of mucin (mucus) of vomits. I observed that the osmotic power of mucin was in inverse ratio to its viscidity, *i.e.*, the more fluid the mucin the greater was its osmotic power: this would account for the great abstraction of water from the bowel which takes place in cholera, &c. I found that the more fluid the mucus the more rapidly it underwent decomposition. This is a point which would be well worth further investigation.

I have noticed that peroxide of hydrogen was rapidly decomposed, with effervescence, by contact with mucus. From this reaction I believe that peroxide of hydrogen may become of great use to

the surgeon for cleansing wounds from fœtid discharges. It has this advantage over carbolic acid: for whereas the latter depends for its action upon the coagulation of the albuminous principles, the former burns them up and destroys them by oxidation. As soon as the peroxide of hydrogen added in sufficient abundance ceases to effervesce, the surgeon may rest assured that no matter which is in a decomposing state remains in the wound. About 2 to 3 drachms of peroxide of hydrogen to a pint of water is about the proportion most suitable for washing out cavities, stumps, &c.: it may be used with perfect impunity, as no bad effect can result from its use. The cost of a 10 per cent. solution is about 6d. per oz. I have used it with good effect myself in washing out the bowels of choleraic patients, and at same time giving 2 or 3 drams of the 10 per cent. solution as a dose internally. The second or third dose will usually stop vomiting, and the diarrhœa rapidly diminishes. It may be worth a trial in infantile diarrhœa. It might, too, be worth while using it as a spray in diphtheria.

Last year I had a brood of chickens attacked with gapes, which is a fatal disease to chickens, and is caused by a minute worm in the throat (Fasecolo trachealis) which causes inflammation of the windpipe and suffocation. Knowing it is almost universally fatal, I thought it might be possible to destroy the worm by rapid oxidation. I therefore

gave to each chicken that was attacked one drachm of peroxide of hydrogen, with the result of saving the whole brood. This may be the result of the direct action of peroxide upon the air passages in the act of swallowing; or nascent oxygen may be given off by the rapid decomposition of peroxide and be inhaled by the lungs.

If such a comparatively highly organised structure as a worm was destroyed by peroxide of hydrogen, fresh experiments in this direction may afford some clue to destruction of lower forms of vegetable and animal life, and may possibly become of great importance in the consideration of the etiology of zymotic and parasitic disease.

I have noticed that upon giving peroxide of hydrogen to persons suffering from diabetes the quantity of sugar was not unfrequently increased, whilst the specific gravity of the urine was diminished, which leads to the inference that a substance is at times voided in diabetic urine, which by oxidation is readily changed into sugar. From other considerations I have no doubt that the substance is of a nitrogenous origin, but I have never been yet able to isolate it so as to be able to determine its exact composition.

I am led to this conclusion from the examination of urine voided before and after peroxide of hydrogen had been taken, and also by observing the effect upon the urine by making a diabetic patient breathe

for some considerable time—half to one hour—oxygen derived from the decomposition of water. I have found that in urine voided after the inhalation of oxygen the quantity of sugar was almost constantly slightly increased and the specific gravity diminished: but by making the same person breathe air to which hydrogen from the other pole had been added, no effect was produced upon the urine. He was unable long to breathe the air, as it affected his larynx.

In some diabetic urine, with a high specific gravity, and relatively small quantity of sugar, if a few drops of peroxide of hydrogen were added and the urine was kept 12 to 24 hours at 98° F., the specific gravity frequently fell and the quantity of sugar increased. A platinized platinum wire will carry down oxygen, and if inserted into this kind of urine, sugar will be increased and specific gravity diminished.

I have noticed that whenever a patient was passing this kind of urine, he rapidly lost weight.

The following table shows the effect on urine by the patient breathing oxygen derived from decomposition of water:

	Before.			After.	
	Urine.	Sugar per oz.		Urine.	Sugar per oz.
Sp. g.	1035	29.8	Sp. g.	1026	23.5
	1035	22.4		1035	25.5
	1035	16.8		1030	19.9
	1032	19 9		1031	24.3

The following shows the increase of sugar in urine after voiding, by a slight addition of peroxide of hydrogen, and keeping the same at 98° F.:

Sp. g. 1036 ; 17.5 grains of sugar per oz.
Same urine after HO_2 for two hours
Sp g. 1037 ; a slight rise, 25.1 grains of sugar.
After fifteen hours the Sp. g. had fallen to
Sp. g. 1032 ; sugar increased to 29.4.

The following shows the increase of sugar and the diminution of specific gravity by keeping urine at a temperature of 98°, and conducting oxygen down by means of a platinized platinum wire:

Sp. g. before	1037	13.2	after 1032	15.1
	1036	15.5	1031	18.0
	1037	21.0	1030	22.3

but urine containing mucus is liable to further decompose the sugar, especially if kept at the temperature of the body. A patient in Faith Ward, Saint Bartholomew's Hospital, in the year 1866, passed a large quantity of water which contained traces of sugar, but the specific gravity never exceeded 1020 and frequently fell to 1005 and 1004, sometimes containing traces of sugar and sometimes none at all. I find from my notes from May 28th to June 3rd, the specific gravity of the urine varied from 1010 to 1015, and contained, from mere traces of sugar, up to 18 grains per ounce. All the specimens became rapidly turbid, and deposited a thick flocculent precipitate. Some urine freshly voided, passed on Monday, June 4th, had only a specific gravity of 990 by urinometer, and also by sp. g. bottle.

This urine had a strong aromatic smell, rapidly

became turbid, with an evolution of gas. In urine voided a few hours later, the specific gravity rose to 1002; next day the specific gravity rose to 1020, with 24 grains of sugar, and the day after again fell to 1010 with 20 grains of sugar.

It is evident that fermentation had been set up in the bladder, for the evaporation to dryness of the urine of specific gravity 990 gave 12 grains of sugar to the ounce.

The following table shows the quantity of urine passed by a diabetic patient in 24 hours, and the amount of food and liquids taken during the same period.

Time.	Quantity taken.
1 a.m.	Biscuit, ¼ pint brandy and water
3.30 „	¼ pint brandy and water
5 „	Medicine, ½ biscuit, ¼ pint toast and water
„	1¼ pint tea, 3 rounds of toast, rasher of bacon
8.15 „	Biscuit and butter, ¼ pint toast and water
10.15 „	Pint beef tea
10.30 „	Biscuit, small piece of bacon
11.45 „	¼ pint toast and water
12 noon	Medicine
1 p.m.	Beef steak, potatoes, biscuit, pint of porter
2.40 „	½ pint toast and water
4 „	Pint of tea, biscuit, 2 eggs
6 „	½ pint toast and water, medicine
7 „	Beef steak, 2 biscuits, pint of porter
11 „	Biscuit and butter, ½ pint toast and water

Time.	Quantity passed.
3 a.m.	2¼ pints.
6 „	¼ „
8 „	¼ „
10.10 „	1 „
12 noon	¼ „
2.45 p.m.	¾ „
4.30 „	½ „
6.5 „	¼ „
7.10 „	½ „
7.50 „	½ „
11 „	2 „

One of the remarkable circumstances attending diabetic cases is that the quantity of water passed by the kidneys is almost invariably largely in excess of the amount of fluids taken. The following table gives the quantity of drink taken and urine passed by day and by night for a whole week.

	By Day.		By Night.	
	Drank.	Passed.	Drank.	Passed.
Sunday	6	7	2	3
Monday..........	7	6½	2	4
Tuesday.........	6½	7	2	3
Wednesday ...	6	7	2	4½
Thursday	6½	5½	1½	4
Friday	6	6	2	4
Saturday	6½	7	2	5
	44½	46	13½	27½

Although I have made some thousands of examinations of diabetic urine, I am convinced a much more detailed mode of examination is required than that usually practised at our hospitals.

The sugar in the above examinations was estimated by taking the mean of five readings of the Soliel's saccharometer. I hope I have said enough to show the significance which chemistry may have to the Clinical Practitioner, and I will now pass to the consideration of the foregoing upon public health.

Considerable attention has of late years been called to the question of the water supply of London, and

its relation to the distribution of typhoid fever and diarrhœa.

It is held by many chemists that the water supply of London, which is drawn principally from the Thames and the Lea, is largely impregnated with previous sewage contamination, and is totally unfit for dietetic purposes. Dr. Frankland in this sense reported of the Thames water during August and September, 1880. Let us see how this belief accords with the views of those who hold that summer diarrhœa is brought about by impure water, and that the mortality from that disease may be taken as a measure of the amount of impurity consumed.

On turning to the Tables of Mortality published by the Registrar General, I find the average rate of mortality per week from diarrhœa, for a period between 3rd and 4th weeks of August and 1st and 2nd weeks of September, was for every 100,000 persons living as follows :—

District.	Water Supply.	Deaths.
South	Thames, Kent Co.'s wells	10
East	Lea	8
North	Thames, New River ...	8
West	" " ...	5·4
Central	New River	9
Charlton and Woolwich	Chalk wells	
Barking and Ilford ...	South Essex	10
Carshalton	Chalk wells	21
Croydon	" "	9
Brighton	" "	8.5

District.	Water Supply.	Deaths.
Tottenham	Deep Well	14
Birmingham	Not stated	17
Leicester	Brooks and springs ...	27·5
Stratford	Lea	26
West Ham	„	29
Leyton	„	3
Walthamstow	„	21
Ilford	South Essex	17
Barking	„	34
Dagenham	Surface Wells ...	Nil
Eltham	Kent	5·5
Lee	„	9·5
Lewisham	„	11.5
Sydenham	Thames	6.5

From this table it would appear that the diarrhœa of last summer had little to do with the source of water supply. But further consideration of it suggests that localities which were water-logged suffered most from diarrhœa; and it is evident from the above table that the mortality from diarrhœa differed greatly in districts which drew their water supply from the same source.

The relation of sub-soil drainage to summer diarrhœa of infants appears therefore to furnish a promising field for future investigations.

The power of water as a distributor of disease was well illustrated by Dr. Thorne Thorne's report to the Local Government Board on the epidemic of typhoid fever at Caterham and Redhill. He clearly demonstrated that a small quantity of typhoid stool casually discharged into the well and thence to the

reservoir, so minute in quantity as to escape detection by chemical analysis, nevertheless spread the disease over a very large area; proving that very minute quantities of enteric poison could diffuse through large volumes of water without diminishing its energy.

In connection with this subject it is desirable that the attention of the medical officers to certain rural sanatory authorities and the directors of water companies which draw their supply from the chalk should be directed to a serious danger which is likely to arise at no distant date to their wells, and gathering ground by an increase in their neighbourhood of new houses with cesspools. It is evident that by constant and increasing pumping the level of the water in the chalk may have a tendency to be lowered, and that consequently the springs may suck and draw upon the liquid contents of these cesspools. Should, however, a cesspool be made by accident over one of the fissures so common in chalk, the contents will pass at once directly into the underground streams which flow through the chalk.

Thus, by a direct coarse fouling of the water, I believe a danger may be apprehended at any moment. It may become necessary for the welfare of the community that fresh Parliamentary powers should be obtained for a compulsory system of impervious drainage in chalk districts whence a potable water supply is drawn.

It is just possible that the poison of typhoid fever

may by future investigation turn out to be the ova or germ of some parasite which sets up a fever with lesions specially obvious in the intestines. This view is to some extent supported by the observations of Mr. Power in 1879 into the so-called outbreak of continued fever on board the "Cornwall" training-ship. On examining the muscles of a boy who had died of the fever, he found therein, and in abundance, a nematoid parasite, which led to the diagnosis of trichiniasis. But this parasite differed in some respects from trichina, in that it was not encysted, and was also more watery and transparent. This induced Mr. Power to examine the bodies of persons who had died of typhoid fever, with a view to discover whether a microscopically visible organism might not exist elsewhere than in the intestines, and which might be concerned in the etiology and pathology of the disease. On investigating the muscle of enteric fever, he discovered a seeming parasite, infinitely smaller than that found in the "Cornwall" epidemic. Whether these bodies are of vegetable or animal origin has yet to be determined.

It is constantly alleged, when typhoid fever has occurred in a private house, that the cause was due to the fouling of the water in the cistern by sewer gases escaping up the waste-pipes of water-closets. I have no doubt that fever may have too hastily been ascribed to this cause when other causes may have really been operative.

The resident engineer of a water company which drew its supply from the chalk told me that the company had a large covered tank reservoir, to supply a town of 4,000 inhabitants. The overflow-pipe of this tank he discovered to his horror had been, by the carelessness of the British workman, in direct communication, without any trap of any kind, with the main sewer of the town, in fact, was the principal ventilating shaft for the sewer, so that for every pailfull of water which was drawn off by the inhabitants an influx of gas from the sewer to the tank took place. It was not until ten years had elapsed from the building of this tank that some repairs to the reservoir took place, when the untrapped state of the pipe was discovered. Nevertheless no epidemic of typhoid fever had invaded the town during that period. It would be incredible to conceive that the sewer had been entirely free from infective matter of enteric fever for ten years.

If it should turn out on further investigation that particulate infection of enteric fever is a germ or ovum of a parasite, it would be easy to account for its diffusion through fluids, and would indicate the improbability of its dissemination by sewer gas. An experiment is now in operation, under the supervision of the well-known analyst, Mr. Odgston, at Antwerp, of supplying that town with water drawn from the River Neth after filtration through spongy iron, which is well worth the attention of chemists and

those who are interested in the question of public health. The quantity of organic matter in water is reduced to less than one-eighth by filtration through spongy iron; while free ammonia, and nitrates are largely increased at the expense of albuminoid matter. If the sanitary condition of Antwerp improves under the new water supply, and should future investigations support the theory which I have ventured to put forth, that ova and germs of disease can be destroyed by oxidation, then it will have become practicable to obtain drinking water from sources which have heretofore been regarded as inadmissible.

This leads to consideration of epidemics of typhoid, scarlet fever, and diphtheria, which have been proven by the medical officers of the Local Government Board and others again and again to have arisen through milk supply.

The following account of illness in my own household last year, which may have some connection with a milk supply, is also worthy of record:—

The household consisted of myself, wife, and my aunt, together with five female servants, to which must be added a dog, a cat, a monkey, and a parrot. On May 8th I was attacked with a sore throat. May 9th, the cat was noticed to have a large glandular swelling on the neck: the monkey also fell ill that day. On May 11th, the parrot was evidently out of health. On making an investigation, I found that members generally of the house-

hold took very little milk, and that only which had been previously boiled, or to which tea had been added. The dog had no milk; but myself, the parrot, cat, and monkey had drunk a considerable quantity of uncooked milk. On inquiry, I found from my cow-man that on May 1st one of the cows was attacked with what he considered a boil on the udder; but when I examined her on the 12th there was nothing but a small scab to be seen. The milk of this cow had been mixed with the others, and from total quantity the house was supplied.

The butter churned on 6th and 10th—that is, from cream taken from milk of 2nd to the 5th, and 6th to the 9th—took a long time in coming, and the butter became rancid on the second day.

The milk in question did not become ropy, and neither by microscopical examination or chemical analysis was it found to differ from normal milk. The above facts may have been a mere coincidence; but it is not impossible it along with other evidence suggests a new departure toward the investigation of polluted milk supplies.

In connection with the consideration of milk as an article of diet, I am induced to quote the observations made by Dr. H. J. Paine in his annual report on the sanitary condition of Cardiff for the year 1878. Although my experience in this disease differs somewhat from his researches, nevertheless I consider his observations so valuable and of so

much interest that they deserve to be more extensively known. He states, speaking of the prevalence of a severe epidemic of epizootic of foot-and-mouth disease which occurred in his district during 1875:—

"Concurrent with this epidemic, my attention was "directed to a severe form of sore throat prevalent "amongst children, especially in the neighbourhood "of Whitchurch and Llanishen, where the foot-and-"mouth disease existed in nearly every dairy. Al-"though very severe, and in one or two instances "coming under my observation, fatal, it differed in "some of its essential characteristics from diphtheria, "its mortality was not nearly so great in proportion "to the number attacked with the disease, there was "none of the albuminoid secretion accompanying "diphtheria, but the disease presented a vesicular "character, attacking the uvula, tonsils and pharynx. "In two or three cases vesicular bullæ were observed "about the finger nails; a very careful microscopical "and analytical examination was made in every case "when the samples of milk could be obtained, and we "rarely failed to find evidences of a diseased condition "of this secretion. In all cases where this was dis-"covered, the use of the milk was prohibited, and its "prohibition marked the subsidence of the disease "amongst the children in that locality. In the acute "stages of foot and mouth disease when the udder is "affected the secretion becomes less in quantity and "peculiarly rich in solid matter, and the constituent

" compounds are generally present in abnormal pro-
" portion. When chemical evidence could not throw
" much light upon the character of the milk, the
" microscope invariably disclosed some peculiarity
" foreign to healthy milk, and in most instances the
" appearances thus afforded were so uniform and
" conclusive as to leave no room for doubt that
" the milk was drawn from a diseased cow. As an
" illustration of the difference observed in the chemi-
" cal composition of the milk of cows suffering from
" foot and mouth disease, the following analyses (1
" and 2) of diseased milk are given, and the compo-
" sition of healthy milk (3) inserted for comparison :—

No.	Water.	Fat.	Casein.	Lactin.	Ash.	Total Solids.
1	76·40	9·91	8·01	4·69	0·99	23·60
2	81·80	7·01	5·92	4·77	0·80	18·20
3	85·94	4·00	5·01	4·31	0·74	14·06

" The following are characteristic microscopical ap-
" pearances :—During the earlier stages of foot and
" mouth disease, before the mammary glands appear
" to sympathise or become observedly affected, neither
" the chemical or microscopical evidences are strongly
" marked. There is, however, one peculiar character
" noticeable, viz., the affinity of the fat globules to
" aggregate in masses, leaving a portion of the micro-
" scopical field uncovered. In healthy milk the fat

" globules are equally distributed throughout the field " of the microscope, and they are generally symme- " trical in form and the caseous envelopes present no " peculiarities. The microscopical appearance of the " milk from a cow suffering from eczema epizootica in " the first stage shows this aggregation of the fat " globules, and also reveals an abnormal condition of " the caseous envelope, which is seldom spherical, and " which from its fluorescent appearance seems to indi- " cate that the casein exists in a somewhat modified " form. As the disease advances, and the mammary " glands are affected, the microscope shows that the " milk contains numerous foreign ingredients and " altered constituents. The colour heightens—colour- " ing matter resembling diluted hæmatin is present " and not unfrequently blood can be detected by the " guaiacum and peroxide of hydrogen test. Pus cells " —characteristic epithelium scales, animal mem- " brane, and numerous animal matters like dried " blood, etc., possibly from sores on the teats, are " present. At this stage the caseous envelopes of the " fat globules appear very thin and glairy, mucous- " like, and intensely refractive. The caseous en- " velopes are irregular in form and deficient in " tenacity, so that a portion of the butter fat is " liberated and several particles aggregate and yield " a streak of refractive matter, which may fre- " quently be mistaken for foreign bodies under the " microscope. In the acute stage of the disease the

" milk is usually acid when fresh drawn, and although " the casein is not readily coagulated the globules " of butter fat collect in small masses, and when a " drop is let fall on a slip of glass stellate crystals of " fat are seen. If a sample of milk so affected is " shaken for a few minutes a considerable lump of " butter fat may be caused to separate and collect. " The stellate crystals of fat are of less size as the " disease terminates, and the disposition of the fat " globules to aggregate ceases when the disease is " entirely removed from the system. Bacteria make " their appearance in this milk in a very short time, " but it is somewhat uncertain if they are ever pre- " sent in the milk when it is in the udder unless the " latter is very seriously affected.

" On several occasions during the prevalence of " infantile diarrhœa, I have had samples of milk " examined by Mr. Thomas, who has detected pus " cells, and hæmatine in the milk used by these " children, and on cnquiry Mr. Moir has found " gargit, or mammitis, that is suppurative inflam- " mation of the teats or udders of the cows in the " dairy from whence the milk was obtained ; I have " then enjoined the use of condensed or Swiss milk " with great advantage. It is, therefore, highly " desirable that in all cases where children are " suffering from infantile diarrhœa, the medical " gentleman in attendance should ascertain the " quality of the milk supplied to the sick child.

" Upon a recent occasion the attention of the
" Pathological Society was called to some cases
" of diphtheria assumed to be due to the consump-
" tion of diseased milk, and it was upon this occasion
" that the committee, to which I have alluded, was
" delegated to enquire into the subject. I can but
" feel, if the committee embraced some of the
" members of the veterinary profession, and enlarged
" its area of enquiry, extending it not simply to
" the probable causation of zymotic disease, but also
" to that of constitutional diseases, great results
" would be obtained. It is well known that dairy
" cows suffer extensively from tuberculosis or
" phthisical disease, and a strong opinion has been
" expressed that the milk obtained from cows suffer-
" ing from this disease can communicate it to the
" human species.

" Veterinary hygieinists confidently affirm that
" cows kept in badly constructed, filthy and ill
" ventilated sheds, readily succumb to this disease;
" that its presence is detected by the gradual wasting
" of the animal with the usual concomitant symptoms;
" that during this time lactation is constantly kept
" up, and the milk used for human consumption."

We have here a number of suggestions of great value for future observers, and without accepting every one of Dr. Paine's opinions, I would point out to the promise they give for a better understanding of the complex etiology of infectious disease,

The questions which appear to me to require to be solved are:—

1. Is the milk only causative of disease to man by direct addition to it of infective matter previously derived from man?

2. Is the milk of cows suffering from disease capable of becoming *per se* an infective agent to man?

3. In either case is the fatty matter or the albuminous matter the constituent of the milk which carries infection?

4. May not milk under favourable conditions (which have not been yet determined) be at times a breeding ground for infective matter?

5. How far does cooking of milk modify or destroy the infective property connected with it?

These are some of the points which should engage the attention of the medical profession; but it is impossible for any medical man in large practice to give that continuous labour in his laboratory to perfect those experiments in physical and chemical research which the elucidation of these phenomena require.

The following experiments carried on simultaneously under the condition of atmosphere and temperature were made to determine the influence of a varying quantity of oxygen, held in solution by water, on the life of fish.

The results are of some interest, as showing that

an excess of oxygen produced a very rapid destructive influence upon animal life.

1st. The first experiment was placing 5 dace in 5 pints of water, ordinary river water exposed to air; at the end of 12 hours 4 fish were living, one was dead; after 60 hours, 2 fish still remained alive, but at end of 84 hours all were dead.

2nd. The second experiment was placing 5 dace in 5 pints of water, to which had been added 4 oz. of peroxide of hydrogen; at the end of 12 hours all the fish had died.

3rd experiment. Five dace were placed in 5 pints of water, to which 2 drs. of peroxide had been added; after 12 hours, 1 dead, 4 living; after 60 hours 2 were still living; after 84 1 still living, but after 100 hours all were dead.

4th experiment. Five dace were placed in 5 pints of water, to which 1 oz. of hydrated peroxide of iron had been added; after 12 hours all fish were dead.

5th experiment. Five dace were placed in 5 pints of water, to which 1 dram of the same peroxide had been added; after 12 hours 4 fish were alive, 1 dead; after 60 hours 1 still living; at 84 hours all dead.

I have observed that the exposure to the influence of light, or a sudden rise in the temperature of water above 50° F., is destructive to the incubation of trout and salmon ova. There are other conditions equally fatal, but their exact nature has yet to be determined. A fall of temperature of the

water considerably below 50° F. appears only to retard the process of incubation. I am inclined to think that stronger fish are hatched from ova whose incubation has been retarded by cold.

I believe we have yet to learn that a variety of conditions have, each or all of them, no little influence in the development of spores, germs, or ova of many species, and that the conditions favourable for development in the above sense as regards different species may be utterly dissimilar. Some of such conditions are, no doubt, temperature and range of temperature, amount and state of oxygen in the medium wherein the protoplasm is environed, and last, but not least, light. As an example of conditions deferring development, I may cite the grain of wheat which, after 2,000 years in an Egyptian sepulchre, still retained its germinal power. Again, the spores of the common mushroom are well known, under unfavourable conditions, to remain indefinitely dormant. So, too, the ova or germ of parasites may and do remain dormant until a host be found for them. I do not here presume to formulate the conditions which may or may not be favourable to the development of the germs of any given species; but I believe that it will in the end be found that small divergences from the conditions favourable to their evolution may be fatal to the vitality of ova of higher animal forms; while a larger divergence can be borne by spores, germs,

and ova of species low in the scale of vitality, always providing that the unfavourable conditions stop short of chemical destruction of the germ or ovum.

A method of detecting ammonia and other impurities existing in the atmosphere may be obtained by the following simple appliance. A glass funnel, drawn out to a point and closed at the end, and supported in an ordinary stand, is filled with ice; condensation of the watery vapour of the atmosphere then takes place, the dew collects in drops, which trickle down the outside of the funnel, and at last fall from the point, under which a small receiver is placed to catch them. The total quantity of liquid collected in a given time is then measured, and the quantity of ammonia determined by the Nessler test.

By this method of distillation by cold it is possible to distil many substances which are decomposed at a high temperature. Thus many delicate odours of flowers can be isolated by placing the flowers under a bell glass sufficiently large to cover them along with the funnel containing the ice.

The odours are found to be more rapidly and completely abstracted by placing a dish with a little ether under the bell glass at the time of distillation.

The same method may be used for the collection of the molecules thrown off from the body in cases of disease, and the products then submitted to microscopic and chemical analysis; but this

method of research, which promises so much to the etiology of epidemic diseases, has not yet been sufficiently cultivated.

An interesting series of experiments might be devised by the addition of a small quantity of grape sugar to fluids collected from various sources, to solve the question of the influence of a fluid to set up fermentation.

The following Table shows the amount of fluid and quantity of ammonia per gallon in fluids collected from various sources :—

Fluid Collected in Minims.	Ammonia in Grains per Gallon of distillate.	Source.
140	·8439	Garden.
55	6·8807	Air escaping from Drain.
90	2·1000	Bedroom.
420	2·9568	Stable.
86	1·0996	Scarlet Fever Ward.
80	1·4784	,,
100	2·3654	Erysipelas ,,
	·3942	From Greenhouse.

I have frequently observed that on shaking up these condensed fluids into an acidulated solution of permanganate of potash the permanganate has been rapidly decolorized, showing that organic matter in an unoxydised state was present. The number of cubic centimetres required for the oxidation of the organic matter in air from various localities is given in the following table (a cubic

centimetre of the permanganate solution is equivalent to 8 hundredths of a milligramme of active oxygen), and for the sake of comparison, the number of grains of ammonia per gallon estimated by the Nessler test has been likewise tabulated.

Cubic centimetres of Permanganate discoloured per gallon of distillate.	Ammonia per gallon.	Source.	Date.
204.1	·3942	From house	April 20
84.4	·4928	Garden	„ 27
233 3	·6899	„	May 8
116.6	·3942	Rain (London)	„ 8
495·8	1.0841	Garden	„ 9
194·4	·3942	„	„ 12
279·9	·5913	„	„ 14
216.5	·9856	„	„ 16
302.8	·7884	„	„ 17
99·9	3·9424	Floor of Stables	„ 18
262.5	394·24	Loft over Stables	
311.0	·6899	St. Thomas's Hospital.	„ 26

It is therefore evident that this amount of oxidizable matter in these fluids has no relation to the quantity of ammonia present.

I have observed on days when the greatest amount of ammonia was detected, the electric currents were either very feeble or totally absent. In many cases these spores of fungi have been detected in the stains left on microscopic slides by the evaporation of these condensed fluids.

In a few cases fungoid growths have been developed in these fluids after they had been allowed

to stand two or three days. Further observations, however, are required upon this interesting phenomenon.

I have given a plate showing the microscopic appearances of a few stains left by the evaporation of these fluids condensed from various sources.

These researches deserve to be carried on to a further point, as they promise to be of much practical utility, and I venture to think that work of this character is especially deserving of the department of State that deals with questions of health.

In this connection it is almost incredible that the Government of the richest State in the world begrudges the expense of the few hundreds a year which would be incurred by the publication and distribution to the medical profession of those valuable and original researches on the etiology and pathology of disease which have been reported by their own medical officers.

I shall now endeavour to show that much food for reflection can be obtained, and lines of investigation of disease indicated by statistics.

At the present time, when small-pox is epidemic, and spreading throughout London, I wish to call attention to a table which I have had constructed from the weekly returns of the Registrar-General for 1880. This striking fact will be noticed, that whilst in London, with a population of 3,600,000, during the year 456 of its inhabitants succumbed to small-pox,

equal to a mortality of 0·126 per thousand, the 17 other great towns of England, with a population of over 3,800,000, lost only 10 inhabitants; but Dublin on the other hand, with a population of 314,000, lost 246 persons from this loathsome and prevalent disease. (*See Tables.*)

It is evident that from some cause, at present not defined, small-pox has become endemic first in Dublin and afterwards in London. It would be most desirable that an investigation should be made under Government authority to discover the causes which are at work for the maintenance and recrudescence of this disease in Dublin and London.

Is it that a larger proportion of the population of these towns evade the law for vaccination?

Is the presence of infectious hospitals in the midst of the cities the cause and nidus for farther outbreaks?

Is the vaccine lymph, after passing through a series of human generations worn out, and its protective power lost?

Can the virus of human small-pox be communicated by inoculation to the cow?

Will the virus of human small-pox undergo any modification in the cow?

Has grease or scab any relation to small-pox or vaccinia?

Is it possible to carry out efficiently vaccination Acts in such large towns as London, with its ever ebbing and flowing population?

Here are questions which the public want to be answered, yet how is it possible that an exhaustive examination on these questions of vital importance to the community can receive a satisfactory solution when the medical officers of the Local Government Board are notoriously so short-handed that it is almost impossible to spare inspectors to make investigation into the etiology of disease without a corresponding neglect of the routine work.

It may be well to consider what, if any, effect, age, occupation, or geographical distribution, have in the production of disease in individuals and communities.

By the statistical examination into causes of death it is first absolutely necessary to reduce, for the sake of comparison, the numbers to some common denominator.

There are two methods for this investigation ; first, a comparison of the proportion of deaths from each class of disease, at different ages, assuming 1000 deaths at each age ; or, secondly, which is by far the best method when possible, comparing the number of deaths from each class of disease at different ages of life to the number of persons living at that age, and then reducing the same to a common denomination : this will shew the chance of dying from a definite disease in one year at each age of life, and the influence of age on the mortality of the disease.

I propose by this latter method to bring under

your notice a short sketch of the chance of death among males from the principal diseases at different ages of life from a table constructed from the Registrar General's Returns for the ten years including 1861-70. In order that the amount of mortality from each class of disease may be more readily recognized, I have had a diagram constructed to illustrate the mortality from various causes for every 100,0co persons living at each age.

On a study of this diagram, it will be observed that zymotic disease is most fatal to infants of under one year; in fact, it is about twenty times higher than for the remaining ages. It will be observed that the mortality falls steadily and regularly to the age of fifteen. It then falls slowly to thirty-four, when it again begins to rise, and rises more rapidly towards the end of life. The curve for cancer cannot be traced until twenty-five, when it rises steadily to seventy-five, and then remains practically stationary. Deaths from so-named tubercular and scrofulous diseases, however, are higher for the first year of birth; fall to fourteen; again rise rapidly to twenty-five, slightly rising to forty-four, when it again declines to the end of life.

Diseases of circulation rise practically with age. Male children appear to die more excessively from diseases of the nervous system than female. Mortality from nervous disease is lowest at nine and advances again to the end of life. The mortality

to children under one year is excessively high from lung disease, and again a rapid rise takes place after forty-four.

Diseases of the digestive organs fall from the first year of life. The lowest mortality is reached at age fourteen, when it rises to eighty-four. Kidney disease falls from birth to age twenty, when a gradual rise takes place. Deaths from violence are pretty evenly distributed until twenty-five, when a gradual rise takes place. Suicide begins at fifteen and rises steadily to sixty, when a gradual decrease takes place. The deaths among females correspond with those of males, with the following exception :—The deaths among female children of the first year of life are less than among males from zymotic, nervous, and respiratory diseases. The mortality from tubercular and scrofulous diseases falls from birth to puberty, when it rises rapidly, and has attained the maximum intensity at age thirty-five, from which point it again rapidly descends. The only other points worthy of remark are the childbed curve, which begins at nineteen, rises rapidly to thirty-five, remains fairly stationary to forty-four, when it terminates abruptly at the end of the child-bearing period, forty-five; the suicide and violent death curves are less than those of males at corresponding ages.

It occurred to me as to others that further investigation was advisable with regard to the curve for

zymotic disease, especially to attempt to discover what was the special cause of the excessive mortality during the first year of life. I therefore thought it advisable to separate the zymotic diseases into their component parts. From this I soon discovered that the main cause of the excess in infantile mortality by zymotic disease was diarrhœa. It is remarkable that diarrhœa is more fatal to male children as compared with an equal number of female. With this exception the curves for other zymotic diseases are almost identical; so the remarks that I shall make are applicable to both sexes. The drop in the mortality from diarrhœa is very rapid from between one and two; it then steadily drops to ten, and remains with little variation to fifty-four, when it again rises rapidly with age. Small-pox falls from birth to age fourteen, rises rather sharply to twenty-four, and again falls to the rest of life. There is here demonstrated the protective power of vaccination; for the relatively high mortality during the first year of life is beyond doubt due to the fatality of the disease among children who have not been successfully vaccinated. And, also, it indicates that infants who have escaped vaccination are to a large extent killed off during the early years of life by this disease. The marked increase which takes place in the mortality from this disease at ages fifteen to twenty-four points to the necessity of a fresh re-vaccination about that

period. The protective influence of the first vaccination appears to be rapidly diminished at puberty. Measles is highest at age one, and falls to fourteen, when it practically disappears. Scarlet fever rises rapidly to one, still rises to two, diminishes a little at three, decreases more rapidly at ages four to ten, practically disappearing at fourteen, and vanishes at fifty-four. Diphtheria rises to age one, diminishes at age two, increases again at three, from which point it constantly diminishes in intensity. Whooping cough diminishes constantly and regularly from birth, disappearing at age fourteen. The typhus and typhoid curves are united, the Registrar-General not having separated enteric from typhus fever during the whole of the period from which these observations are taken. The mortality of cholera is remarkable for being highest at the beginning and end of life.

The cause of the excessive mortality to infants under one year of age demands the fullest inquiry.

It is lamentable to think that more infants perished under one year of age from zymotic disease during the years 1861 to 1870 than the total mortality of men who fell in battle throughout Europe during the same period.

In view of this circumstance, it is still most lamentable to remember that our Government, whilst permitting the expenditure of many thousands a year at Shoeburyness in experiments in

perfecting engines for the destruction of human life, begrudges the expense of increase to the staff of the medical officers, who alone are in the position to thoroughly investigate the cause, and determine the remedies to be applied to lessen this mortality among infants.

For the examination of geographical distribution, and the effect of occupation upon disease, I have been obliged to adopt the method of a comparison of the proportion of deaths from the great classes of disease, assuming 1000 deaths for each occupation. Unfortunately, very little reliable information on this important point exists at the present time, and I am indebted for the construction of this table of occupation to the statistics which have been published by the "Gresham" and "Prudential" Insurance Companies.* (*See Tables.*)

In many occupations the number of deaths have been too small to give reliable results; but the ten dency is so well marked, that great results might be expected if the Registrar-General of England were to return yearly the number of deaths in each occupation, sub-divided into the principal classes of disease. The investigation would have greater value if at the Census, which will be taken in April of the current year, an attempt was made to obtain a

* I am indebted to Mr. Ackland, the Assistant Actuary of the Gresham Life Assurance Society, for having carefully revised and checked all the tables and diagrams.

return of the number of persons engaged in the various occupations and professions throughout the country.

A study of this table shews that the professional classes and factory operatives under 20 years of age suffer most from zymotic disease.

Female operatives, coachmen, labourers, and the professional classes have the highest mortality for diathetic disease.

Among male and female factory operatives, miners, bricklayers, including stonemasons, and clerks, the heaviest mortality takes place from tubercular disease. The mortality of seamen from this cause is far below the average of other occupations.

Traders and professional classes show the highest mortality from diseases of the nervous system.

Disease of the heart is high amongst traders, from which it would appear that the constant anxiety of carrying on large financial transactions has a prejudicial influence over the heart nutrition. Seamen and hotelkeepers suffer severely, but less than the occupation before mentioned.

From disease of the respiratory organs, coachmen, bricklayers, and out-door labourers and miners are most affected.

The mortality from disease of the digestive organs is highest amongst publicans; whilst the working classes appear to suffer least from this cause.

In disease of the urinary organs, publicans and traders suffer most.

The diseases of the organs of generation require no comment.

In developmental diseases (age and debility) bricklayers and out-door labourers appear to the greatest advantage.

From violent deaths seamen, miners and coachmen are far in excess of other occupations.

The extraordinary mortality, amounting to 50 per cent. of the total deaths, both of male and female factory hands from tubercular disease, requires special investigation. It is probable that, apart from nature of of employment, some atmospheric influence exists in our factories which induces and predisposes the workers to tubercular disease. I feel confident that this excessive mortality might be materially lessened by a better hygienic condition of these buildings.

I shall now bring under your notice a table which I prepared for the Gresham Life Assurance Society, showing the influence geographical position has in the predisposition of individuals to certain classes of disease.

In consequence of the whole of the lives having been previously medically selected, and the death certificates relating to them personally investigated by myself, the influence of climate is well illustrated by the diagram which has been constructed from the table.

It will be seen that under zymotic disease the mortality of the assured lives in Austria and Italy have reached the high number of 24 and 27 per cent. of the total deaths in that class.

It is also worthy of remark that typhoid fever, which is prevalent in Italy, is almost entirely replaced by typhus in the Austrian Empire. The mortality is less from zymotic disease in Bavaria and France, and England and West Germany (Black Forest) suffer least.

Cancer and diathetic disease appear to be pretty uniformly distributed.

The deaths from tubercular disease have a very definite distribution. They are highest in Germany, Bavaria and England. In France and Italy they are considerably lower — and lowest in the Austrian Empire.

The mortality is highest from diseases of the nervous system in Bavaria and France.

In England and Italy the mortality from diseases of the circulatory system are highest.

Acute disease of the respiratory organs appears to prevail in Italy, Austria and Germany. The common disease appears to be pneumonia. It may be assumed that in Italy the cold blasts from the Alps and Apennines, alternating with hot suns, predispose the inhabitants to this disease.

The over-heated and stove-dried atmospheres in the houses of Germany and Austria appear to have

a prejudicial influence on the health of the inhabitants, which may account for the high death rate in these countries from tubercular disease and disease of the respiratory organs.

Chronic bronchitis is most common in England and as this disease manifests itself only at the higher ages of life, it may be regarded rather as a result of senile change in the lung tissue than as an absolute lung disease.

England exceeds all other countries in mortality from disease of the digestive organs, and points to some habit in our mode of life detrimental to the function of digestion.

It is worthy of note how diseases of the urinary organs preponderate in the beer-drinking countries, England, Bavaria and Austria, against the wine-drinking countries of Baden, France and Italy.

Developmental diseases are numerically higher in England.

So few female lives are insured that deaths from diseases of the organs of generation are too few for any accurate deduction to be made.

Deaths from violence are in England in excess of the other European nations, and it is remarkable that the Latin races are less prone to suicide than races sprung from the Anglo-Saxon stock; and this notwithstanding that life policies are not forfeited on the Continent.

In conclusion, I feel that I have indifferently

fulfilled my task. I must ask the members of the society to judge lightly my shortcomings, and I trust that they will regard the statements which I have ventured to-night to put forth, not as absolutely proven truths, but rather to view them as suggestions which may be worthy of further research.

If I have succeeded in inducing the Profession to investigate more fully these problems, this evening will not have been spent in vain.

WEEKLY DEATHS FROM SMAL

In London and Dublin a

TOWN.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
LONDON	8	4	3	11	13	12	13	13	8	13	11	4	9	13	9	15	18	10	8	10	10	8	10	6
Brighton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portsmouth... ..	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norwich	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plymouth	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bristol............	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Wolverhampton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Birmingham ...	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Leicester..........	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nottingham ...	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Liverpool	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Manchester......	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salford	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oldham	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bradford	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Leeds	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sheffield	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Hull.....	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sunderland......	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Newcastle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
DUBLIN	5	7	5	2	8	3	6	3	4	7	3	4	4	4	4	8	4	11	8	9	9	18	13	14

		Estimated Population.
London	... .	3,664,119
Nineteen Towns	... ..	3,835,319
Dublin	.. ..	314,666

OX DURING THE YEAR 1880

nineteen English Towns.

26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	Totals.
13	4	3	3	4	2	6	4	3	5	5	3	5	2	5	6	7	2	7	17	10	19	10	12	33	15	17	475
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14	10	10	9	7	6	4	5	.	1	.	1	2	1	1	4	1	.	.	1	1	2	2	.	1	1	.	266

	Deaths.		Deaths per 100,000.
..	475	... ...	12·96
..	10	.. ...	0·26
..	266	.. ...	84·53

ENGLAND, 1861—1870, MALES. *Number*

CAUSES OF DEATH AT VARIOUS AGES.	*0*	*1*	*2*	*3*	*4*	*5*	*10*	*15*
Small-Pox	134·3	61·1	49·9	42·1	32·4	15·0	5·6	9·
Measles	296·8	644·5	320·7	167·6	93·9	23·0	2·6	·
Scarlatina	220·1	538·4	596·5	579·9	471·5	221·8	46·8	14·
Diphtheria	66·1	92·5	76·0	79·4	65·5	33·8	10·7	5·
Whooping Cough	698·6	536·5	227·4	113·9	59·6	12.3	·5	·
Typhus	89·8	132·8	142·2	135·7	118·8	88·1	62·2	78·
Diarrhœa and Dysentery	2066·9	584·0	115·5	42·0	23·9	8·4	3·3	3·
Cholera	64·5	29·3	17·0	11·8	10·6	7·6	4·1	2·
Other Zymotic Diseases	261·5	276·5	215·5	176·0	121·8	37·8	14·2	15·
Cancer	·6	·8	1·5	2·1	1·6	·8	·8	2·
Scrofula and Tabes	587·0	350·1	127·2	57·2	37·9	27·8	21·8	19·
Phthisis	171·2	150·9	76·4	45·5	38·4	43·1	60·5	218·
Hydrocephalus	504·9	410·9	166·9	96·3	68·3	32·6	9·3	2·
Diseases of Brain	3987·6	712·1	289·6	170·3	116·3	59·7	33·5	37·
Diseases of Heart, and Dropsy	79·1	39·5	28·1	23·3	23·4	23·3	25·2	31·
Diseases of Lungs	3128·0	1583·0	556·4	276·4	160·1	55·3	19·9	31·
Diseases of Stomach and Liver	461·1	79·7	45·3	28·3	24·9	20·5	19·2	23·
Diseases of Kidneys	10·5	12·4	12·2	12·6	10·8	8·5	6·5	10·
Diseases of Generative Organs	1·2	·4	·3	·3	·2	·1	·1	·
Diseases of Joints	8·3	8·3	6·8	6·7	5·9	9·5	10·2	10·
Diseases of Skin	68·2	13·7	5·1	2·7	2·6	1·3	1·5	1·
Childbirth and Metria	—	—	—	—	—	—	—	—
Suicide	—	—	—	—	—	—	·4	2
Other Violent Deaths	260·1	137·7	124·9	107·3	90·9	60·0	75·3	83
Other causes	6857·9	940·0	209·8	77·3	49·0	24·5	11·8	11

ses of *Death*, *reduced to* 100,000 *living at each Age.*

20	25	35	45	55	65	75	85 Upwards.	Causes of Death at Various Ages.
8·1	13·7	9·8	6·8	4·8	3·8	2·9	3·6	Small-Pox.
·7	·4	·4	·2	·1	·1	·1	·7	Measles.
8·0	4·7	2·3	1·6	·8	·5	·8	·7	Scarlatina.
3·5	2·4	2·0	2·2	3·0	3·3	3·2	2·9	Diphtheria.
·04	·03	·1	·04	·1	·1	—	—	Whooping Cough.
82·3	70·4	79·3	90·4	115·9	146·9	150·9	137·4	Typhus.
4·9	7·2	10·5	19·3	49·3	145·1	383·6	704·7	Diarrhœa and Dysentery.
4·1	6·7	9·9	14·4	19·0	24·0	25·6	17·4	Cholera.
13·2	16·2	23·8	34·1	61·3	117·6	193·2	267·6	Other Zymotic Diseases.
2·7	6·1	20·6	53·9	120·8	187·7	229·1	232·7	Cancer.
16·8	12·8	9·7	10·7	14·0	15·7	9·3	7·3	Scrofula and Tabes.
388·4	409·2	416·5	386·0	329·7	202·4	69·8	34·2	Phthisis.
·8	·5	·3	·2	·2	·3	·2	—	Hydrocephalus.
44·2	70·4	134·2	224·4	466·5	1094·8	1961·2	2225·3	Diseases of Brain.
34·5	66·5	123·3	218·7	458·1	922·9	1299·2	1145·4	Diseases of Heart, and Dropsy.
52·3	86·0	172·2	350·0	758·7	1518·5	2519·4	3422·3	Diseases of Lungs.
28·0	44·9	91·1	170·9	305·8	493·5	535·7	469·1	Diseases of Stomach and Liver.
13·7	23·8	40·6	65·8	127·9	289·7	504·0	570·9	Diseases of Kidneys.
·2	·3	·8	1·0	1·6	3·1	3·8	5·8	Diseases of Generative Organs.
8·9	7·0	7·6	9·9	15·0	20·2	21·0	15·3	Diseases of Joints.
1·9	1·9	2·9	5·7	11·1	23·6	37·2	58·9	Diseases of Skin.
—	—	—	—	—	—	—	—	Childbirth and Metria.
5·9	9·3	16·3	26·2	37·5	35·7	25·6	20·4	Suicide.
95·7	99·1	114·4	129·2	151·2	165·9	206·7	366·5	Other Violent Deaths.
16·5	30·2	57·8	94·9	247·1	1253·5	6475·1	21647·9	Other causes.

ENGLAND, 1861—1870, FEMALES. *Number a*

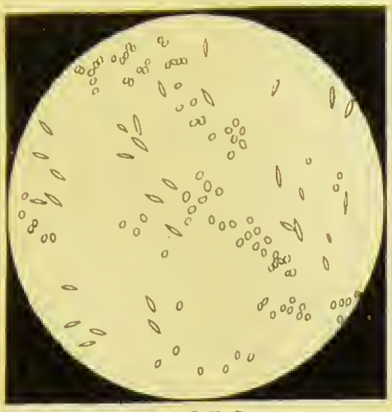
CAUSES OF DEATH AT VARIOUS AGES.	0	1	2	3	4	5	10	15
Small-Pox	122·7	65·5	51·7	43·2	32·0	14·0	5·6	8·0
Measles	250·4	603·9	326·5	178·5	99·8	25·4	3·2	1·3
Scarlatina	185·0	495·9	584·9	557·6	461·9	214·5	53·4	15·7
Diphtheria	50·0	89·2	84·5	87·0	81·8	44·8	16·6	6·1
Whooping Cough	752·6	678·2	318·9	170·4	90·1	18·2	1·1	·3
Typhus	74·2	35·2	151·6	141·7	137·2	96·6	79·8	91·1
Diarrhœa and Dysentery	1743·4	579·4	115·7	40·8	21·7	9·0	2·9	3·4
Cholera	53·0	26·7	13·7	10·5	10·5	7·1	3·3	2·6
Other Zymotic Diseases	217·5	240·2	204·5	167·4	113·6	34·6	15·0	13·6
Cancer	·6	1·0	1·4	2·2	1·6	·7	·8	1·7
Scrofula and Tabes	480·9	321·1	118·1	54·2	35·2	21·1	17·3	17·1
Phthisis	149·6	145·4	76·8	49·2	42·9	47·6	104·5	311·0
Hydrocephalus	342·4	289·2	130·0	78·8	56·8	25·6	8·5	2·2
Diseases of Brain	2969·1	635·5	278·4	168·6	106·7	54·0	31·8	39·1
Diseases of Heart, and Dropsy	67·7	37·9	23·9	20·9	19·3	20·9	28·7	34·1
Diseases of Lungs	2345·6	1462·2	559·4	289·5	170·9	55·0	22·0	30·6
Diseases of Stomach and Liver	305·6	72·4	37·0	28·4	25·8	19·0	15·2	22·9
Diseases of Kidneys	6·9	9·9	7·9	8·0	6·3	4·8	4·4	6·3
Diseases of Generative Organs	·4	·9	·5	·3	·07	·05	·3	1·7
Diseases of Joints	6·9	7·2	5·5	5·4	5·7	6·1	7·1	7·5
Diseases of Skin	56·4	13·0	6·2	3·1	2·5	·9	1·1	·9
Childbirth and Metria	—	—	—	—	—	—	·03	16·1
Suicide	—	—	—	—	—	·01	·3	3·0
Other Violent Deaths	237·3	107·1	88·2	72·4	55·4	31·5	13·1	11·7
Other causes	5624·6	915·6	218·9	85·7	51·1	24·2	12·4	14·2

...uses of Death, reduced to 100,000 *living at each Age.*

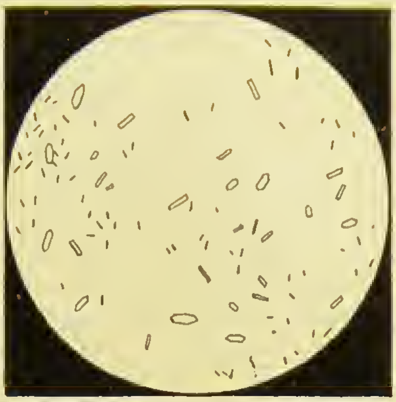
...20	25	35	45	55	65	75	85 Upwards.	Causes of Death at Various Ages.
9·5	7·0	5·0	3·2	2·5	1·5	1·6	1·4	Small-Pox.
1·0	·9	·6	·3	·1	·1	·1	—	Measles.
10·5	7·3	3·3	1·2	1·0	·6	·6	—	Scarlatina.
4·1	2·8	2·2	2·2	2·2	2·1	2·0	1·8	Diphtheria.
·1	·1	·03	·01	·03	·1	—	—	Whooping Cough.
72·2	64·1	70·7	78·5	95·9	115·2	124·4	93·2	Typhus.
5·9	9·7	12·7	18·4	48·3	141·0	363·8	659·9	Diarrhœa and Dysentery.
4·1	7·2	10·1	11·6	15·5	20·3	21·9	26·0	Cholera.
11·6	12·4	16·1	23·9	47·9	95·3	161·4	206·0	Other Zymotic Diseases.
3·3	16·3	67·3	153·8	230·0	281·0	284·4	271·3	Cancer.
12·9	10·6	9·8	10·8	12·1	12·3	9·9	4·6	Scrofula and Tabes.
396·6	437·8	390·0	285·0	206·5	123·9	47·5	26·0	Phthisis.
·8	·4	·3	·2	·2	·2	·1	—	Hydrocephalus.
40·6	55·0	93·0	181·6	401·5	931·4	1707·3	1921·6	Diseases of Brain.
39·0	63·1	119·1	217·5	476·2	943·1	1244·4	930·7	Diseases of Heart, and Dropsy.
38·3	61·3	113·0	232·7	587·5	1311·1	2216·6	2812·1	Diseases of Lungs.
32·4	50·9	90·9	158·0	297·9	471·2	555·0	468·1	Diseases of Stomach and Liver.
10·2	15·7	24·3	31·6	50·8	72·3	73·5	67·1	Diseases of Kidneys.
4·6	9·9	19·7	30·5	34·1	36·4	28·7	18·7	Diseases of Generative Organs.
5·2	5·1	6·0	8·4	11·1	15·5	15·2	11·4	Diseases of Joints.
1·8	2·4	3·1	4·7	9·4	19·3	33·6	40·2	Diseases of Skin.
63·3	92·1	88·8	6·0	—	—	—	—	Childbirth and Metria.
3·1	3·5	5·2	8·3	8·6	8·3	7·2	5·0	Suicide.
8·7	10·1	13·9	20·0	31·5	63·6	189·2	424·2	Other Violent Deaths.
16·0	22·8	38·3	67·1	206·5	1213·9	6354·3	20374·9	Other causes.

Table showing the Geographical Distribution of each class of Disease, reduced to 1,000 *deaths in each country.*

Causes of Death.	England.	France.	West Germany.	Bavaria.	Austria.	Italy.
Zymotic	98	161	69	140	236	269
Diathetic and Cancer	68	78	87	53	77	31
Tubercular	170	146	275	193	121	31
Diseases of Nervous System	151	245	156	281	110	161
,, ,, Circulatory Organs	113	89	81	35	88	108
,, ,, Respiratory Organs	132	125	194	140	209	215
,, ,, Digestive Organs	102	83	56	35	60	85
,, ,, Urinary Organs	66	22	31	88	49	39
,, ,, Generative Organs	3	5	—	—	5	15
Age and Debility	53	5	13	—	6	15
Violence	41	36	38	35	33	31
Unknown	3	5	—	—	6	—



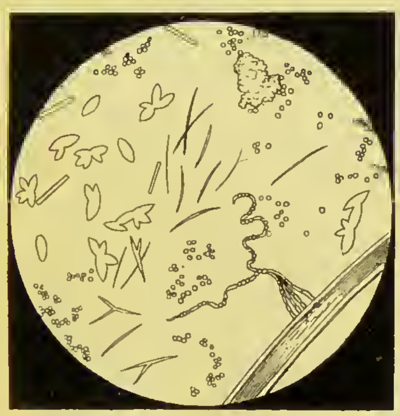
ROSES



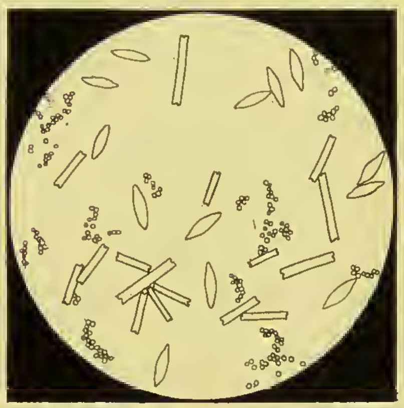
RED PINK.

STOCKS.

ERYSIPELAS IN WARD.

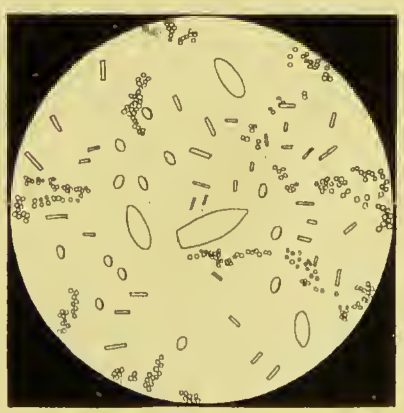


SC. FEVER IN WARD.



WARD IN CONSUMPTIVE HOSPITAL.

PYŒMIA IN WARD.



LONDON FOG

DIAGRAM *Illustrating the Geographical Distribution of each class of Disease reduced to 1,000 Deaths in each Country*

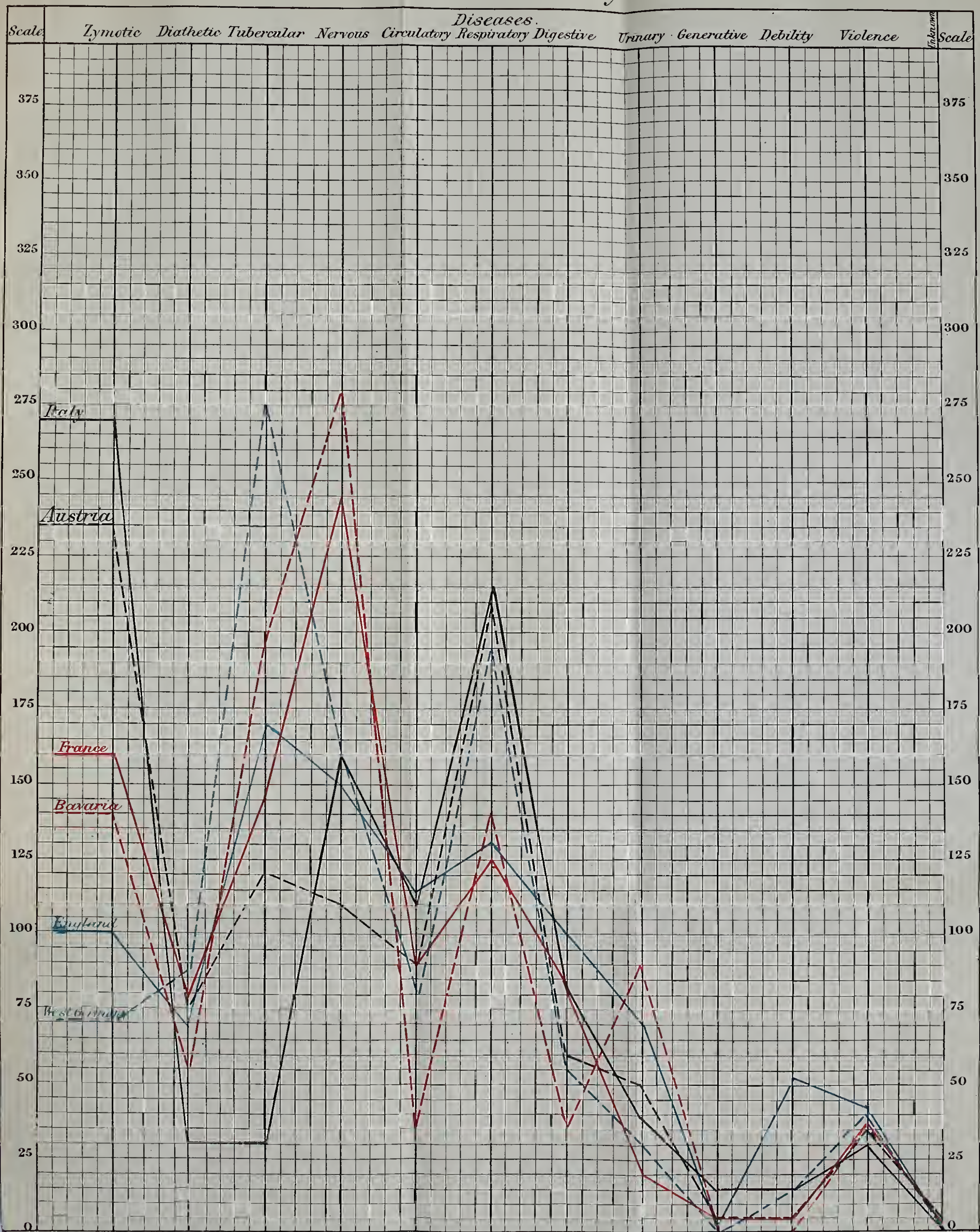


DIAGRAM *shewing the Proportion of Deaths from each class of Disease arising in various occupations. Reduced to 1000 Deaths in each occupation.*

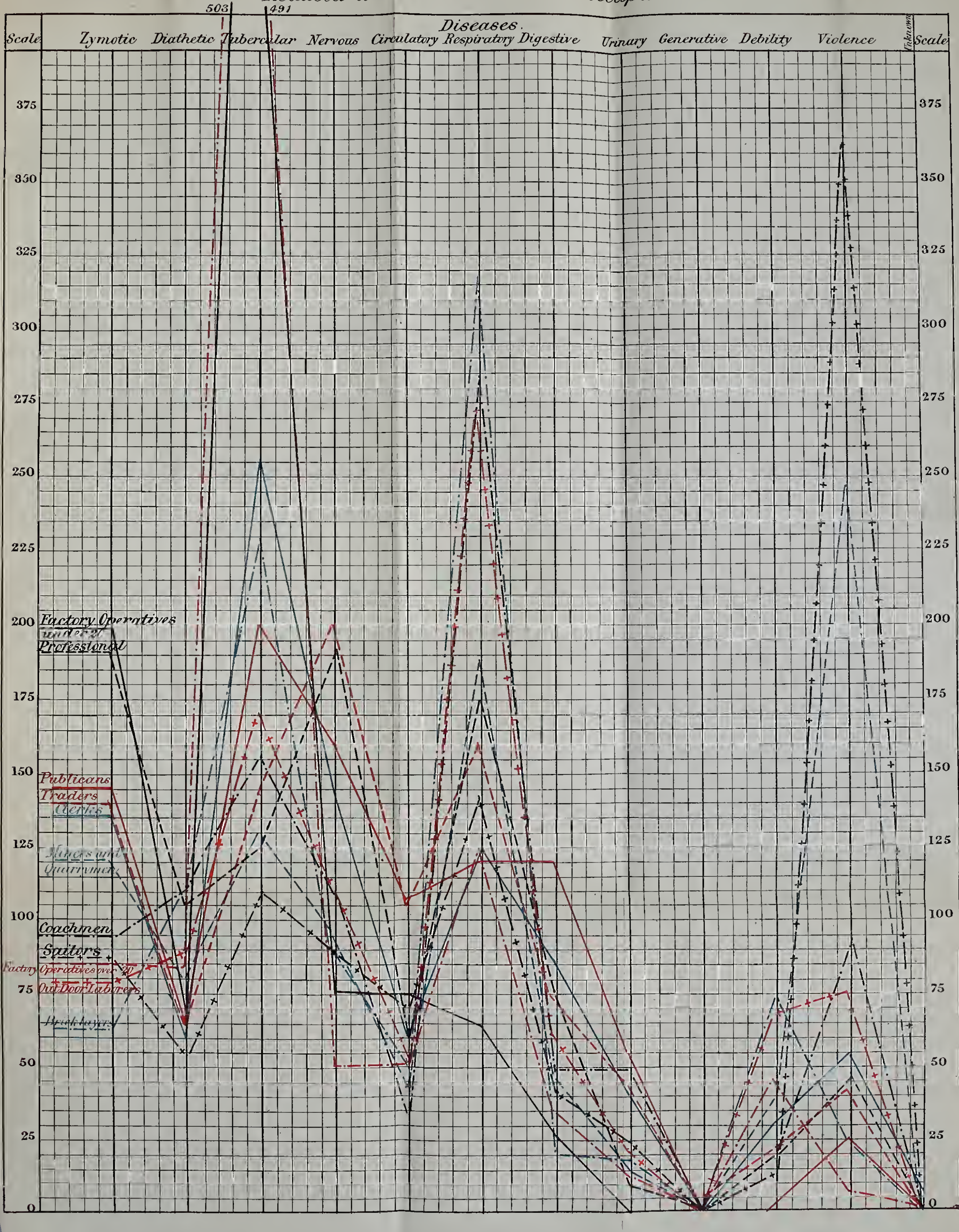


DIAGRAM *Illustrating Number & Causes of Death from Zymotic Diseases of 100,000 Males living at each age*

ENGLAND 1861—1870.

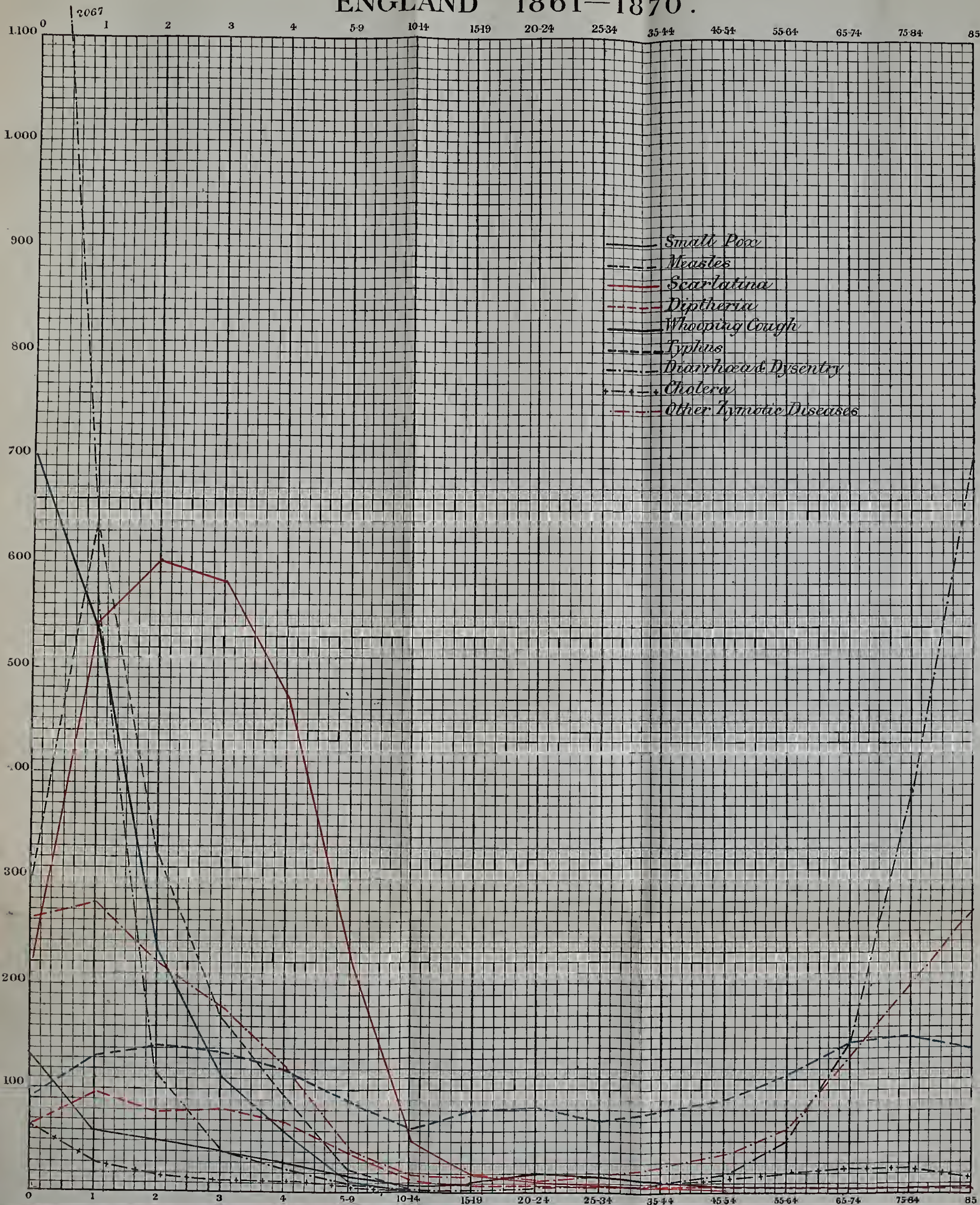


DIAGRAM *Illustrating Number and Causes of Death of 100,000 Males living at each age.*

ENGLAND 1861—1870.

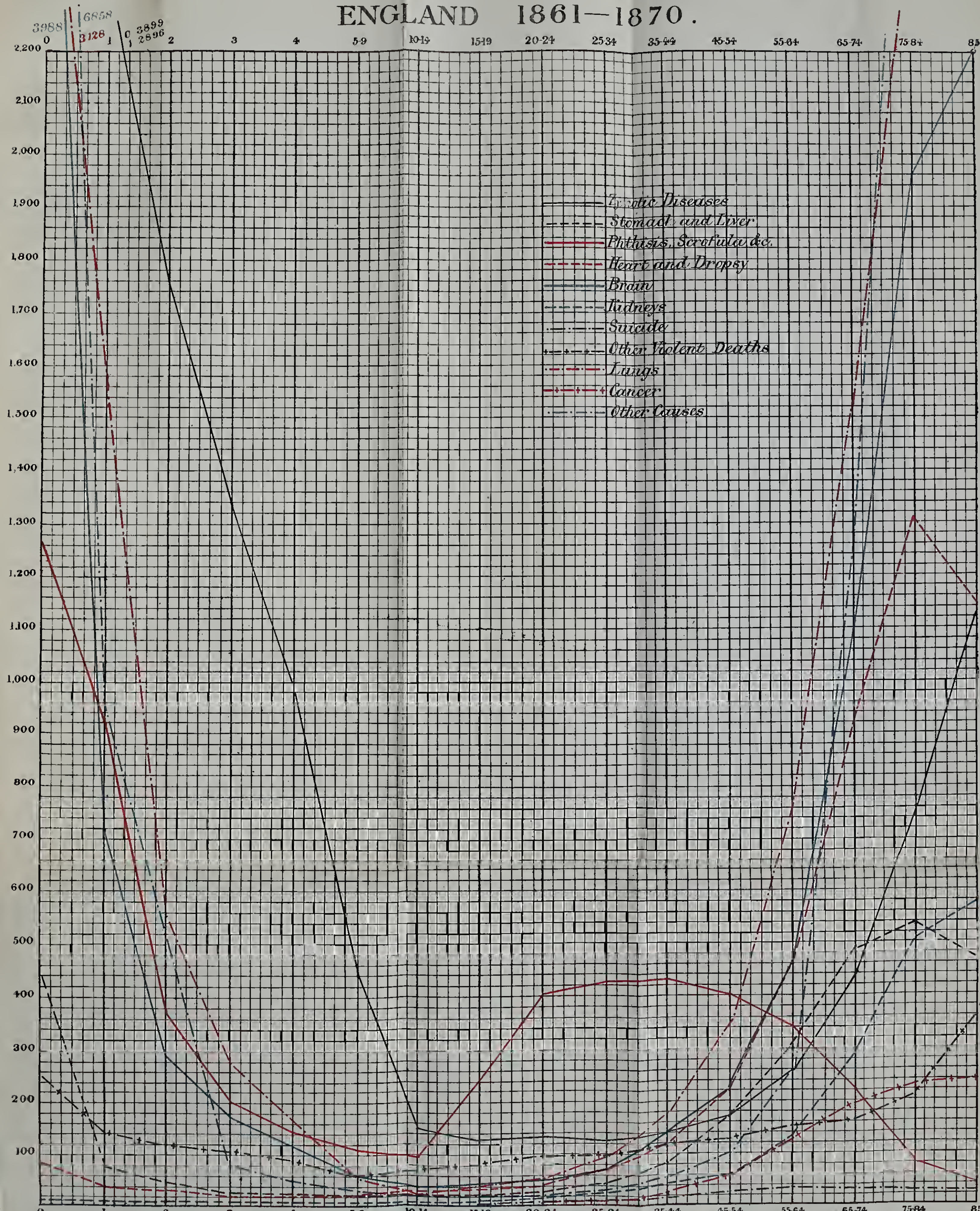


DIAGRAM *Illustrating Numbers & Causes of Deaths from Zymotic Diseases of 100,000 Females living at each age.*

ENGLAND 1861—1870.

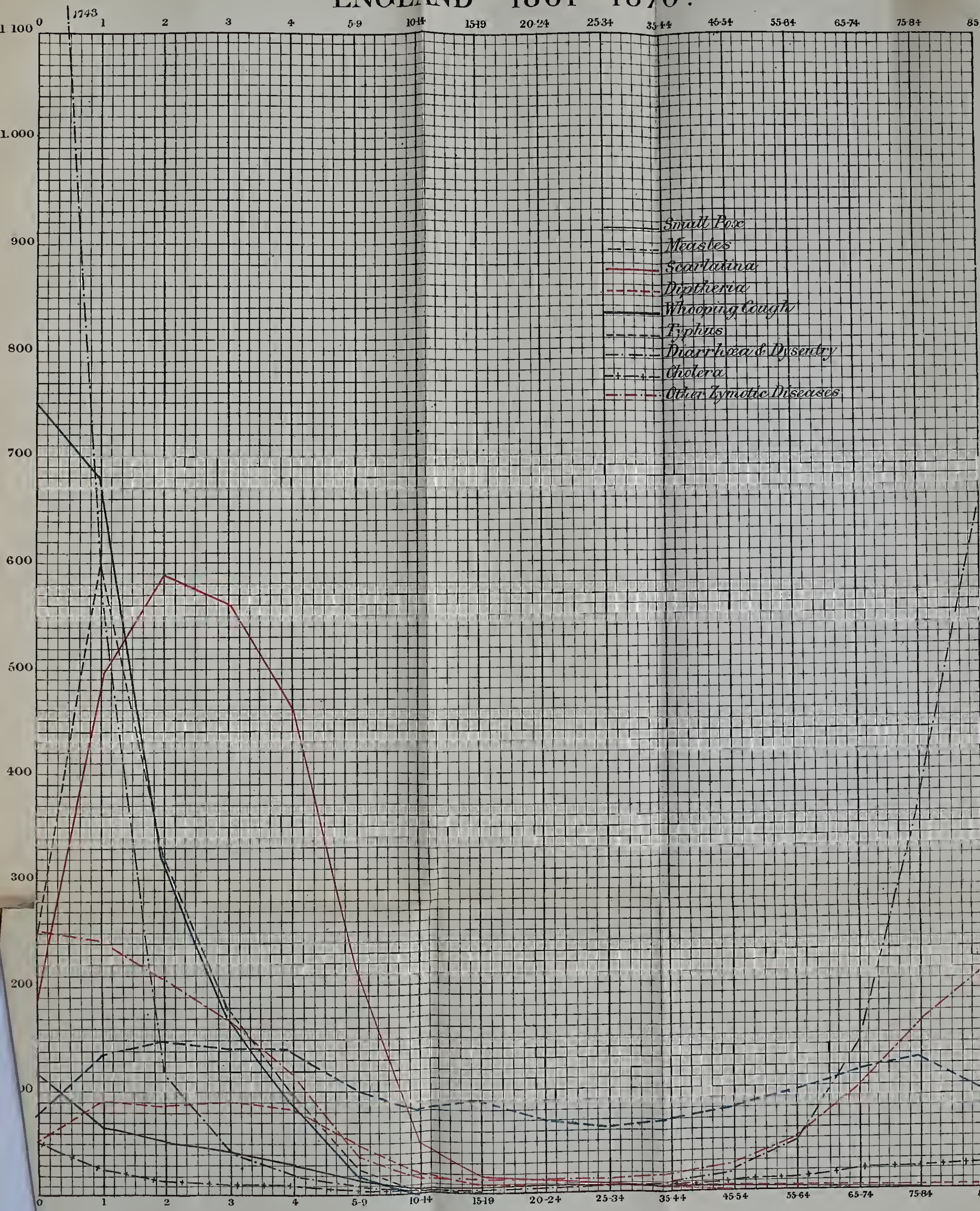


DIAGRAM *Illustrating Number and Causes of Death of 100,000 Females living at each age*

ENGLAND 1861—1870.